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TECHNOLOGY UTILIZATION

COMPUTER PROGRAMS: OPERATIONAL AND MATHEMATICAL

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Foreword

The National Aeronautics and Space Administration and the Atomic Energy Commission have established a Technology Utilization Program for the dissemination of information on technological developments which have potential utility outside the aerospace and nuclear communities. By encouraging multiple application of the results of their research and development, NASA and AEC earn for the public an increased return on the investment in aerospace research and development programs.

This publication outlines several computer programs which are available through the NASA Technology Utilization Program. Section 1 concerns computer operational programs which can be applied to resolve procedural problems swiftly and accurately. Section 2 primarily concerns mathematical applications for the resolution of problems encountered in numerous industries.

Although the functions which these programs perform are not new and similar programs are available in many large computer center libraries, this collection may be of use to centers with limited systems libraries and for instructional purposes for new computer operators.

Additional information on individual items can be requested by circling the appropriate number on the Reader Service Card included in this compilation, or from: COSMIC, 112 Barrow Hall, University of Georgia, Athens, Georgia 30601.

We appreciate comment by readers and welcome hearing about the relevance and utility of the information in this compilation.

Jeffrey T. Hamilton, *Director*
Technology Utilization Office
National Aeronautics and Space Administration

For sale by the National Technical Information Service, Springfield, Virginia 22151.

Contents

Section 1. Operational Programs

GE-635/SC-4020 PLOTTING PACKAGE

This package consists of two programs, each of which prepares tapes for input to the Stromberg-Carlson 4020 cathode ray tube plotter.

The first program, General Plot Program, requires a binary tape in GE-600 floating point format as input. Any variable in the tape record may be used as an independent variable, and may be plotted against one or more of the other variables on one or more graphs. There may be any number of plots from each file of data. Data may be plotted from any number of files on the tape. A start and stop value may be specified for any variable (not necessarily the independent variable) between which plotting will occur for each N^{th} increment of this variable. However, this value is expected to increase algebraically. Overlay, or plotting more than one variable as the dependent variable on the same graph, may be accomplished by plotting one or more variables from one or more files of data from the input tape. The output from this program is a binary magnetic tape containing instructions for the Stromberg-Carlson 4020 to draw the desired plots.

The second program, Plot Tabular Data on SC-4020, generates a tape compatible with the SC-4020 typewriter mode. The input is a GE-635 standard system BMC printer tape, and the output tape is an SC-4020 tape in print normal format. From this tape, a tabular printout may be produced on the SC-4020.

Language FORTRAN IV (24%), GMAP (76%)
Machine Requirements· GE-635/SC-4020
Source Kennedy Space Center
(KSC-10437)

Circle 1 on Reader Service Card.

GAM-SOURCE IMPROVES INPUT PREPARATION OF DISCRETE ORDINATE TRANSPORT CODE (DOT)

This program was developed to calculate and provide for ready input into the DOT program some necessary data which is ordinarily calculated by hand and keypunched. The DOT program is a two-dimensional discrete-ordinate transport code with anisotropic scattering. Calculations by the DOT program require either a boundary source or a volume-distributed source compatible with the configuration being studied.

GAM-SOURCE prepares this necessary data and the output is in the proper form for ready inputting into the DOT program. The program calculates the total volume-distributed gamma source for all zones by incremental summation of each radial and axial mesh-point in each zone.

Language. FORTRAN IV
Machine Requirements IBM 360, Release 11
Source· Aerojet-General Corp
under contract to
Space Nuclear Systems Office
(NUC-10350)

Circle 2 on Reader Service Card.

PROGRAM FOR GENERATING FORTRAN BATCHES (TBATCH)

This program generates batches of FORTRAN programs for performance evaluation of computer systems. The program has been written so that, with minor alterations of the format statements, it can be used on any digital computer with a FORTRAN compiler.

The program creates a series of FORTRAN programs in which the priority, memory size, compile instructions, computer time, amount of input/output, and the number and type of input/output units can be varied. The effect of varying these parameters is determined by placing calls to the computer clock at selected points in the generated programs and examining the program output after execution of the batch.

Language: FORTRAN V

Machine Requirements UNIVAC 1108

Source. Jet Propulsion Laboratory
under contract to
NASA Pasadena Office
(NPO-11114)

Circle 3 on Reader Service Card.

DDP 24/224 TAPE DUMP

This program lists, on a line printer or on magnetic tape, the formatted contents of any magnetic tape for which a tape dump is required. The program accepts either binary or BCD records, and it is not necessary for the user to specify the mode of the magnetic tape being dumped. Any record length is acceptable up to the practical maximum of 37777 (octal). A choice of formats is available for dumped output. A selection of particular files or records to be dumped is also available. At the discretion of the user, the input tape can be rewound either before or after processing. The length of each record processed is indicated as part of the output. A record count is output at the conclusion of the processing of each file.

Language DAP II

Machine Requirements Honeywell DDP-24, Honeywell DDP-224

Source· C.A. Schneider of
Lockheed Electronics Co.
under contract to
Johnson Space Center
(MSC-13135)

Circle 4 on Reader Service Card

THE RAPID 2 COMPUTER PROGRAM

This program was written to provide a simple and inexpensive computer method for handling any set of records in which each record can be identified by a unique name or number. The program will store, correct, and delete information, as needed, without the use of complicated forms. In most cases, a standard form or list already in use can be adapted. With records established, useful reports or summaries may be produced without the need for computer or programming knowledge on the part of the user. This is done by the use of a simple set of control cards. The method of operation is uncomplicated and is similar to that used in preparing information for typing or correcting a report. Spacing and layout of the report text is determined by the user without special computer instrucions. In this way page composition can be seen by the user and modified as required prior to actual report preparation.

Language: PL-1

Machine Requirements IBM 360, Release 11

Source Rockwell International Corp.
under contract to
Marshall Space Flight Center
(MFS-18870)

Circle 5 on Reader Service Card

IBM-360 UTILITY INPUT/OUTPUT ROUTINES

This program package consists of two assembly language subroutines. The first, BCDFLT, converts from 1 to 12 EBCDIC numbers into a four-byte S/360 floating point word. Fourteen types of characters are allowed as input: zero through 9, a plus, minus, decimal, and an E.

The second subroutine in the package, BCDOUT, converts a four-byte floating point number into EBCDIC representation of the number. The subroutine is designed to be used to allow printout of floating numbers when the I/O package cannot be supported due to core limitations.

Language: Assembly

Machine Requirements: IBM-360

Source: Rockwell International Corp. under contract to Marshall Space Flight Center (MFS-18699)

Circle 6 on Reader Service Card

TIME-SHARING DESK CALCULATOR PROGRAM (COMPUTE)

COMPUTE is a computer program, written primarily in FORTRAN IV, which operates under the IBM 360/67 Time-Sharing System (TSS). COMPUTE allows the TSS user to perform various numerical calculations without writing FORTRAN programs. The user may thus solve various numerical problems while at the TSS terminal by simply communicating with COMPUTE. This report is intended to introduce the user to COMPUTE. It is anticipated that the user will obtain from this introduction the information necessary to begin using COMPUTE More specific information about the capabilities of COMPUTE can be derived from the actual use of the program. This is possible because of numerous error, warning, and information messages generated by COMPUTE and printed at the terminal

Language: FORTRAN IV (82%), Assembly (18%)

Machine Requirements. IBM 360/67 TSS

Source: Lewis Research Center (LEW-10935)

Circle 7 on Reader Service Card

GENERAL FLOW CHART

This program provides a means of producing flow charts of computer programs by using a computer. Any number of flow charts may be accomplished in a single run of the program. Special control cards are used to separate the different programs to be flow charted.

The user specifies each type of flow chart symbol to be drawn and the information to be printed in each. The output of the program is a magnetic tape which, when processed on the SC-4020 plotter, produces the completed flow chart. The program can produce sixteen types of symbols.

Printing within the symbols is accomplished in a manner similar to that used by a typist (i.e., a bell is set to ring as the end of the line approaches). The program then looks for a blank or a comma. If a blank or comma occurs before the maximum line length is used, the line will conclude. If not, the line will conclude at its maximum length.

Language: FORTRAN IV (60%), GMAP (40%)

Machine Requirements GE-635/SC-4020

Source: Kennedy Space Center (KSC-10451)

Circle 8 on Reader Service Card.

GE-635 SYSTEM CERTIFICATION

This program consists of a batch of 13 jobs which will provide basic GE-635 system certification Each job has a special permanent $ SNUMB card to identify Hardware/Software to be checked by the job Jobs contained in the Batch are

$ SNUMB	ITEM TESTED	TEST DESCRIPTION
COMNT	None	Provides operator setup messages on console
PUNCH	Card Punch	Punches a deck to check all row and column positions. (Input to "READR ")
RAPIO	IOC Multi-Operations	Checks for error conditions when IOC is loaded with I/O (simultaneous DRUM, DISC, TAPE, and PUNCH operations)
DRUM	DRUM File	Checks basic WRITE and READ operation.
DISC	DISC File	(Same as DRUM)
PRINT	2 Printers	Checks basic WRITE and CHARACTER selection.
TYPEW	AUX Typewriter	Checks basic WRITE operation.
TAPES	14 Magnetic Tape Units	Checks basic WRITE and READ
READR	2 Card Readers	Checks all rows and columns of deck produced by PUNCH job
COBOL	COBOL Compiler	Provides basic COBOL Software check (Test includes internal sort.)
FORT	FORTRAN Compiler	Provides basic FORTRAN Software check.
GMAP	GMAP Assembler	Provides basic GMAP Software check
UTBMC	UTILITY and BMC	Provides basic BMC and UTILITY Software check.
	GELOAD	Loader verification is provided by all jobs
	GECOS	A good check of GECOS Software is provided by all jobs.
	GEINOS	Direct GEINOS usage in RAPIO, and by the typewriter routine in each job.
	GEFRC	GEFRC Software is utilized by all jobs.
PTAPE	Paper Tape Unit	(System 1 only) Provides allocation check *only* for paper tape unit.

Language FORTRAN (70%), GMAP (30%)
Machine Requirements GE-635
Source Kennedy Space Center
(KSC-10452)

Circle 9 on Reader Service Card.

FORTRAN FLOW CHART

The purpose of this program is to provide the capability of producing computer program flow charts suitable for inclusion in final program documentation utilizing FORTRAN IV type coding. Thus the program precludes the requirement for manual preparation of flow charts and provides a presentation using standard flow chart symbols.

The input to the program consists of one or more FORTRAN card decks, from which all control cards and blank cards are removed If these cards are not removed the program will just compile. Each deck normally starts with a comment card, but may start with a FORTRAN statement. Each deck must end with an End card.

The output from the program consists of a magnetic tape which, when processed by the SC-4020 plotter, produces final computer program flow charts and a cross-reference listing between program statement numbers and flow chart page numbers.

Options of microfilm only or both hardcopy and microfilm are available.

Language FORTRAN IV (5%), GMAP (95%)
Machine Requirements GE-635/SC-4020

Source. Kennedy Space Center
(KSC-10450)

Circle 10 on Reader Service Card.

COM DECK TO SYMBOLIC

This program is designed to take a GE-635 system generated COM Deck, list the deck, convert GE character sets to IBM character sets, and punch a new source deck in IBMF. This will enable a programmer to make changes in the new source deck by using cards punched on the IBM keypunch machines. The new source deck, when assembled, will need a $ INCODE IBMF card preceding it.

Language: FORTRAN IV (10%), GMAP (90%)
Machine Requirements: GE-635

Source: Kennedy Space Center
(KSC-10441)

Circle 11 on Reader Service Card.

PRONTO

This is a generalized report generation program which satisfies the demand for a utility type programming system capable of producing reports, summary listing, and performing utility type operations. The method used is the Pronto Processor which is versatile and easy to learn, code, and debug. The Pronto Process will function under either a TAPE or DISK oriented operating system, but for maximum efficiency the Pronto Processor should be included on the Systems Operating File in executable format.

Language: Autocoder
Machine Requirements: IBM 1410/7010

Source: NASA Headquarters
(HQN-10527)

Circle 12 on Reader Service Card.

FAMILY CARD IMAGE INPUT UTILITY W/OPT PACKING (SPECRAW)

This is a PL-1 computer program written to operate on the ASP/360. The program places family card images on tape for subsequent use in the generation or updating of family files. SPECRAW uses the method of the title option to read in card or tape, and employs record output to write the tape. Special features of the program are optional left-justification packing, and on-line printing of input and output.

Language. PL-1
Machine Requirements IBM 360
Source Rockwell International Corp. under contract to Marshall Space Flight Center (MFS-18689)

Circle 13 on Reader Service Card.

Section 2. Mathematical Programs

PRINTED PLOT GENERATOR

This set of four subroutines provides printed plots as part of normal output.

The subroutine PLOTXY is called for plotting a single curve, while PLOTMY is called for plotting multiple curves. When using PLOTXY, the values to be plotted in the x-direction must be in sequence, if they are not, prior to calling PLOTXY, subroutine SORTXY must be called to make the necessary rearrangements.

For either PLOTXY or PLOTMY, if the range of a variable to be plotted is unknown, the subroutine SKALE must be called prior to calling PLOTXY or PLOTMY.

These subroutines have been generalized so that, if desired, the programmer may choose to use one or more of several options that permit him to control such things as the appearance of the grid, the scale for either variable, and the plotting character.

The programs are almost entirely machine independent and the documentation is written to simplify the changes required to adapt the plotting system to other machine configurations.

Language
Version 1 – FORTRAN IV
Version 2 – FORTRAN G or H
Machine Requirements
Version 1 – IBM 7094/7044 DCS
Version 2 – IBM 360
Source: Lewis Research Center
(LEW-10410) Version 1, (LEW-10857) Version 2

Circle 14 on Reader Service Card.

PARALLAX

PARALLAX was designed to optimize positional data of point (z) on a cartesian coordinate system, with respect to point (x), from point (x) to point (y) when given slant range, azimuth, and elevation of point (y) referenced to (x). It computes cartesian coordinates of positional data for point (z) with respect to point (y). Reference point (y) may be either moving or stationary.

An experimenter, in support of short range vehicle and aircraft flights, may desire his data parallaxed to a remote point such as a radar installation located on the deck of a ship To provide this capability, this program was developed for short range parallaxing.

Language FORTRAN IV

Machine Requirements· GE-625

Source: Wallops Station
(WLP-10037)

Circle 15 on Reader Service Card

SUBROUTINES FOR EVALUATION OF SINGLE AND MULTIPLE INTEGRALS USING MODIFIED ROMBERG METHOD

Double and single precision computer subroutines, ROMBD and ROMBS respectively, have been developed for numerical quadrature using a modified Romberg procedure with a variable step size, automatic error control, and extensive diagnostics for evaluation of single integrals. Subroutine RMB1 with successive calls to RMB2 and a final call to RMB3 comprise the single precision package for multiple integration. ROMBS is used as the basic integration technique.

The routines represent a "state of the art" in their field. They have been thoroughly tested and found to be equal to or better than comparable routines. The programs have been compared to SQUANK (Lyness, J.: Notes on the Adaptive Simpson Quadrature Routine, ACM Journal, Volume 16, July 1969) and found to be more reliable and capable of solving a larger class of problems. Other comparisons are presented in Mathematical Software, edited by J.R. Rice, Academic Press, 1971, pages 229-259.

ROMBD and ROMBS are designed to serve as a library "standard" for solving most of the problems of the form $I = \int_a^b f(x)dx$, it must be recognized that with singularities and certain discontinuities in f(x), other methods may be more appropriate; however, ROMBS is able to integrate successfully many singularities and discontinuities.

These programs are written in FORTRAN V for use on the UNIVAC-1108 computer, but the routines are easily convertible to FORTRAN IV. Comprehensive documentation is available.

Source: W.R. Bunton and
M. Diethelm of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11224 & 11295)

Circle 16 on Reader Service Card.

COMPUTER RUN TIME REDUCED BY TABLE LOOKUP SUBPROGRAM

This program consists of table lookup subroutines which perform the following

a) D=f(I) with $n \geq 27$ dependent variables. Single table lookup.

b) D=f(I,I′) Double table lookup, with one dependent variable.

where D = Dependent variable
I = First independent variable
I′ = Second independent variable

The program stores the tabular data with dynamic packing and uses linear interpolation or extrapolation for lookup.

The interpolation (extrapolation) equations require coefficients which are calculated and stored as the tables are read. When performing a table lookup, the coefficients are then already available, preventing repeated calculations of the same coefficients. This method is thought to be an improvement over storing the tables directly and calculating the coefficients on each lookup.

Language. FORTRAN IV
Machine Requirements: IBM-360

Source The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-15146)

Circle 17 on Reader Service Card

ALGORITHM FOR REDUCING THE NUMBER OF REQUIRED POINTS IN A GRAPHICAL DATA SET

The overspecification of graphs by a large number of points often makes the time required to produce the graphs excessive. A subroutine called RDCPTS has been developed for reducing the number of points required to produce the graph. RDCPTS will produce an accurate and exact graphical display with a much reduced data set. Where plots of lower precision are acceptable, the algorithm can be even more effective in reducing the time and cost required in graphical production.

The technique used in RDCPTS involves testing for deviation from line segments. The subroutine finds a subset of the original set of points such that all of the original points are within a certain tolerance of the line segments defined by the subset. The algorithm used in RDCPTS is fast, but does not necessarily reduce the number of points to the minimum number that satisfy the tolerance. As currently written, RDCPTS cannot reduce the number of points by a factor greater than 32. The first and last points are always included.

This subroutine is particularly valuable for use with Benson-Lehner plots since it can make the plotting much less expensive. In addition, the resulting plots are much sharper and easier to read.

Language FORTRAN H
Machine Requirements: IBM-360

Source The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-15107)

Circle 18 on Reader Service Card.

MATRIX ANALYSIS LANGUAGE (MAL)

This program is designed to provide a tool for engineering personnel which will aid them in the processing of matrix information. The user need only have a basic understanding of digital computers and have been exposed to a basic computer language. In addition, he should have a working knowledge of matrices and matrix operations.

The program accepts matrix oriented statements, analyzes them and outputs a FORTRAN program which will accomplish the desired results. The language is flexible enough to handle any problem from a small, simple one to a large, complex one, also, numerous operations are performed in one statement, thereby decreasing the number of statements required and the number of intermediate matrices needed.

The elements of any matrix are limited to single precision, real numbers The number of matrices defined in one run is limited to 300. As a guide, the number of elements in any one matrix should not exceed 6400.

Language. FORTRAN V (81.9%), MAC (18.1%)
Machine Requirements UNIVAC-1108
Source The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-15052)

Circle 19 on Reader Service Card.

A FORTRAN PROGRAM FOR MACHINE COMPUTATION OF GROUP TABLES OF FINITE GROUPS

A Fortran program has been written for machine computation of group tables for finite groups. The program was written for the NASA Lewis Research Center IBM 360/67 and is machine dependent. The use of the method depends on the fact that every finite group of order n is isomorphic to some subgroup of the symmetric group S_n. (Group A is isomorphic to group B if the elements of A can be put into one-to-one correspondence with the elements of B.)

The procedure for using the program is as follows: The proper isomorphism between the group whose table is desired and the appropriate subgroup of S_n is established. These elements of S_n are entered into the program as input data. The program computes and prints out the group table for these elements of S_n. The isomorphism is again used to translate the S_n elements in this table back to the elements of the desired group.

It should be noted that S_n is of order n. Thus, in practice, one tries to find an isomorphism between the desired group and some subgroup of a symmetric group lower than S_n. Although success in this attempt is not guaranteed, it occurs often enough to make the attempt worthwhile. An example is given in which the group table for A_5 (which is of order 60) is computed. The theorem only gives assurance that an isomorphism can be found between A_5 and some subgroup of S_{60} (of order 60!). Actually, of course, an isomorphism is already found between A_5 and S_5 (which is only of order 120).

Language. FORTRAN H
Machine Requirements IBM-360/67
Source: Lewis Research Center
(LEW-10999)

Circle 20 on Reader Service Card.

COMPUTER PROGRAM FOR SPLINE FIT CURVES

The spline fit curve is a convenient method for fitting a curve through a given set of points. This program will calculate the spline fit curve with function values, first and second derivatives, and curvature at any desired interpolated points.

If a set of function values corresponding to a set of arguments is given, there are several ways a curve can be fitted through these values so as to approximate the original function with these values. The classical way is by an nth degree polynomial for n+1 points. However this may not be satisfactory for a large number of points. Other methods include Least Squares and the Four-Point Lagrangian interpolation. These methods have shortcomings overcome by the spline fit or piecewise cubic fit method.

The spline fit curve gives a simple method of determining an approximating analytical curve which can be used in place of the original curve for interpolation, determining first and second derivatives, curvature, or integration.

Language. FORTRAN IV

Machine Requirements: IBM-7094

Source· Lewis Research Center
(LEW-10917)

Circle 21 on Reader Service Card.

SINGLE VARIABLE CURVE FIT

The Single Variable Polynomial Least Squares Curve Fit (Partial Tape Input) is a FORTRAN IV Program designed to fit points with a smooth curve. It computes a single variable polynomial using up to 30 terms with 200 points of data (maximum). The data points may be weighted with input cards. Storage is in core, 46,000 cells.

The program reads data points (both independent and dependent variables) from a tape and saves only those points needed for curve fitting. Records may be skipped to get to the starting record. The output includes the following

(1) Polynomial coefficients of the terms
(2) Real residuals of N points
(3) Computed function values
(4) Percentages of error
(5) Maximum residual
(6) Sum of the residuals squared
(7) Square root of the sum of the residuals squared

Language. FORTRAN IV

Machine Requirements. CDC-6600

Source General Dynamics Corp.
under contract to
Lewis Research Center
(LEW-10665)

Circle 22 on Reader Service Card

SMOOTHING

This program provides a method for determining the least squares estimated coefficients for a set of data. The data is assumed to describe a Kth order polynomial ($K \leq 10$) over an N point range ($N \leq 101$).

The program uses these coefficients to compute smoothed, fitted, interpolated, or extrapolated data points, plus their first and second derivatives It also performs an error analysis which gives standard errors of estimate for the fit, the coefficients, and the computed points and their two derivatives.

Each input record, whether on tape or cards, is to consist of one independent variable and up to 20 dependent variables. For output, an option is available for writing a binary tape.

Language FORTRAN IV

Machine Requirements GE-635

Source Kennedy Space Center
(KSC-10415)

Circle 23 on Reader Service Card

LAGRANGE THREE-POINT INTERPOLATION PROGRAM

This program generates equally incremented interpolated data, using the Lagrange interpolation formula for equal or unequal intervals of data.

Input to the program consists of the input data set and the following parameters: number of functions to be interpolated, the first and last arguments to be interpolated, and the output options. The input data set may be on cards or tape, the output data set and the interpolated values may be on tape, cards, and/or the printer.

Each point of the input data set consists of an argument followed by as many as 19 functions to be interpolated. Three data points are used to calculate each interpolated point. The points to be interpolated are always maintained between the first and second of the three data points, except for the extrapolated regions. Extrapolation before the data set may be forced by setting the first argument to be interpolated less than the first argument of the data. Extrapolation beyond the available data may be forced by setting the last argument to be interpolated greater than the last argument of the data.

Language: FORTRAN IV

Machine Requirements: GE-635

Source: Kennedy Space Center
(KSC-10418)

Circle 24 on Reader Service Card.

"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

— NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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